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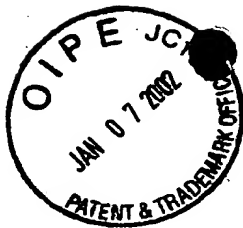
[NAME OF ARTICLE] Specification 1

[NAME OF ARTICLE] Drawing 1

[NAME OF ARTICLE] Abstract 1

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[Document Name] Specification

[Title of the Invention] Method of manufacturing a multi-layered ceramic substrate

[Claim]

1. A method of manufacturing a multi-layered ceramic substrate comprising the steps of forming and firing a shrinkage suppression sheet on both faces of an unfired green sheet laminated body, and removing said shrinkage suppression sheet, wherein said shrinkage suppression sheet is removed by mixing ceramic powder and water, and spraying them together with compressed air.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method of manufacturing a multi-layered ceramic substrate used in an electronic appliance, and more particularly to a method of manufacturing a so-called non-shrinkable multi-layered substrate which greatly suppresses shrinkage of the substrate during firing.

[0002]

[Prior Art]

Multi-layered ceramic substrates are generally manufactured by a method called green-sheet lamination method. In this method, in a green sheet formed from slurry of ceramic powder and organic binder, via holes are opened, a conductive

paste is screen-printed, a necessary number of layers are stacked, heated, pressed, laminated, and fired.

[0003]

It is an advantage of this method that the green sheet is very flexible and is quick to absorb the organic solvent, so that fine pattern can be printed, and also it is excellent in surface smoothness and air tightness, so that tens of layers can be laminated.

[0004]

On the other hand, it is a disadvantage that the dimensional precision is poor. It is because shrinkage occurs in the process of sintering when firing the substrate. As a result, a deviation occurs between the components and the conductor pattern when mounting, and it is impossible to mount semiconductor chips such as CSPs (chip-size packages) and MCMs (multi-chip modules) at high accuracy, which was a serious problem.

[0005]

It has been recently attempted to develop a method capable of eliminating lateral shrinkage itself at the time of firing. In this method, as a substrate material, shrinkage suppression sheets made of ceramics such as alumina not sintering at the sintering temperature of green sheet are formed by doctor blade method, and they are disposed at both faces of the green sheet laminated body, and fired. The fired multi-layered ceramic

substrate shrinks only in the thickness direction, and does not shrink in the lateral direction, so that the semiconductor chips can be mounted at high accuracy.

[0006]

The shrinkage suppression sheets on both faces of the substrate after firing were removed by rotating a dry rotary brush at high speed as shown in Fig. 2. In the diagram, reference numeral 1 is a shrinkage suppression sheet before removal, 2 is a multi-layered ceramic substrate after firing, and 3 is a rotary brush.

[0007]

[Problems that the Invention Is to Solve]

In the conventional removing method, however, it was difficult to adjust the removing amount of the shrinkage suppression sheet by changing the rotating speed of the rotary brush, or distance to the substrate, that is, the strength when polishing the substrate by the rotary brush. When the rotary speed was slow, or the working time was short, uneven removal occurred, or when the rotating speed was excessive or the working time was long, the conductor pattern on the substrate surface was often damaged. In particular, as indicated by A in Fig. 2, if a concave part was formed on the surface of the substrate, it was difficult to remove completely by the rotary brush.

[0008]

[Means of Solving the Problems]

To solve the problems, the invention is intended to remove the shrinkage suppression sheets from the green sheet laminated body of substrate material by low temperature firing by blowing compressed air together with mixture of alumina or other ceramic powder and water.

[0009]

According to this method, the polishing power is increased by mixing ceramic powder in water, and delicate control is possible to varying the pressure of the compressed air, and therefore uneven removal does not occur, and all can be removed from the recess in the substrate.

[0010]

[Embodiment of the Invention]

An embodiment of the invention is described below while referring to Fig. 1. As shown in Fig. 1, shrinkage suppression sheets not sintering at sintering temperature of green sheet laminated body are formed and baked at both faces of the green sheet laminated body made of substrate material by low temperature firing, and then the shrinkage suppression sheets are removed.

[0011]

Reference numeral 1 is a shrinkage suppression sheet made of alumina material, and 2 is a multi-layered ceramic substrate fired at low temperature. Reference numeral 4 is an injection

nozzle, 5 is a feed pipe of mixture of water and alumina powder, and 6 is a feed pipe of compressed air.

[0012]

As the removing condition, when the size of the multi-layered ceramic substrate 2 is 115 mm × 115 mm, and the thickness of the shrinkage suppression sheet 1 made of alumina material is 200 μm, for example, mixing 96 g of water and 4 g of alumina powder, compressed air at pressure of  $3.5 \pm 0.5$  kg/cm<sup>2</sup> can be blown for about 150 ± 30 seconds. The distance between the multi-layered ceramic substrate 2 and the nozzle 4 is about 50 mm. After removing, the surface is washed by using purified water and dried for 15 minutes at 120 ± 5°C. The result of comparison with the conventional manufacturing method is shown in Table 1.

[0013]

Table 1

	Method of invention	Prior art
Working time	Approx. 150 sec	Approx. 300 sec
Fine adjustment and control of removing work	Easy	Difficult
Uneven removal	None	Present
Damage of conductor pattern	None	Present
Processing of irregular substrate	Easy	Difficult
Simultaneous processing of both faces	Easy	Difficult

[0014]

In the embodiment, since the alumina powder which is a same component as the ceramic substrate material of the base is mixed with water, it is free from impurity reaction with conductor paste to cause adverse effects on the laminated body.

[0015]

[Effects of the Invention]

Thus, according to the invention, it is possible to work in a short time without causing uneven removal or damage on conductor pattern. ~~Also in the case of an irregular substrate~~ having a recess on the surface, it can be removed completely. Moreover, by adjusting the ratio of the mixed solution, air



pressure, time, or nozzle distance, the polishing strength can be controlled delicately. Still more, by holding the substrate, the both faces can be processed simultaneously.

[Brief Description of the Drawings]

Fig. 1 is a side view showing a manufacturing method of a multi-layered ceramic substrate in an embodiment of the invention.

Fig. 2 is a side view showing a conventional manufacturing method of a multi-layered ceramic substrate.

[Reference Numerals]

- 1 Shrinkage suppression sheet
- 2 Multi-layered ceramic substrate
- 3 Rotary brush
- 4 Injection nozzle
- 5 Feed pipe of mixture of water and alumina powder
- 6 Feed pipe of compressed air

[Name of the document] Drawing

Fig. 1

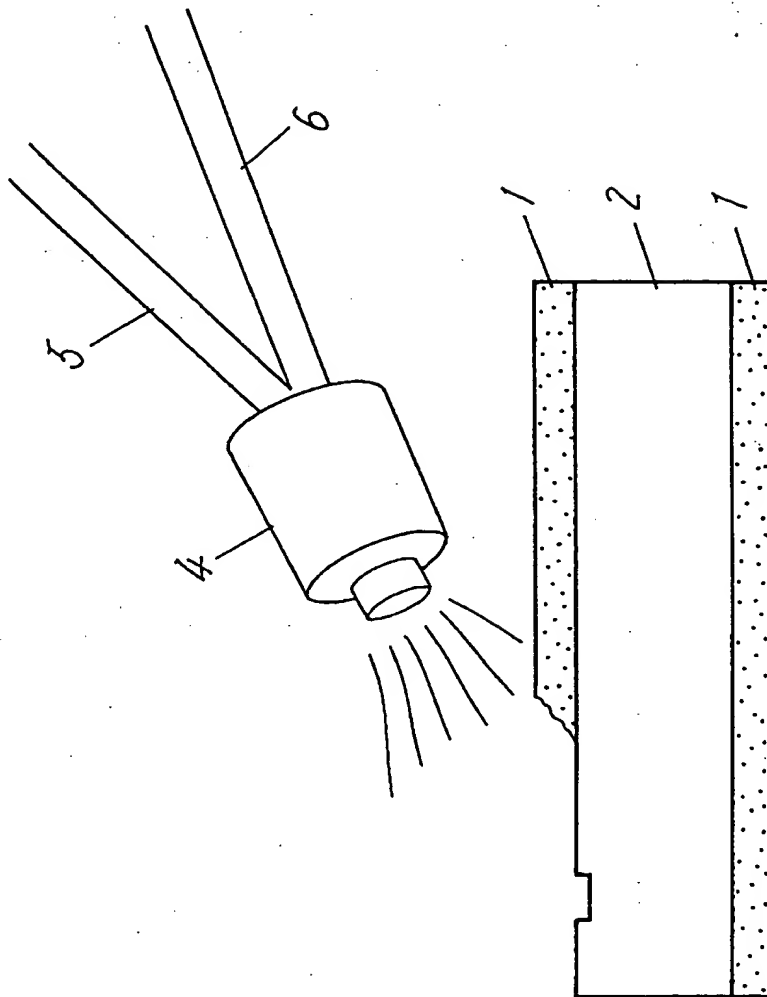
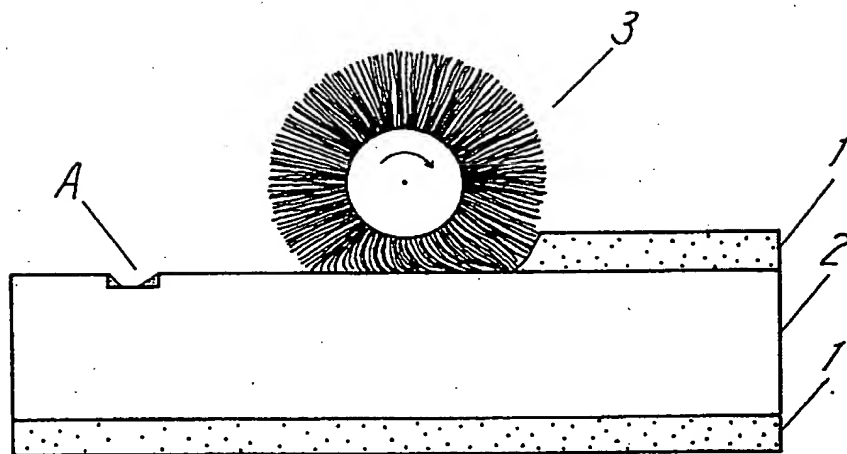


Fig. 2



[Document Name] Abstract of the Disclosure

[Abstract]

[Problem] To improve the method of removing shrinkage suppression sheets, relating to a method of manufacturing a so-called no-shrinkage multi-layered ceramic substrate which extremely suppresses shrinkage of substrate during firing.

[Solving Means] Shrinkage suppression sheets 1 are formed and fired at both faces of an unfired laminated green sheets. In order to remove the shrinkage suppression sheets 1 from both faces of the fired multi-layered ceramic substrate 2, alumina powder which is a principal component of the multi-layered ceramic substrate material and water are mixed, and sprayed together with compressed air to remove them.

[Selected Drawing] Fig. 1.